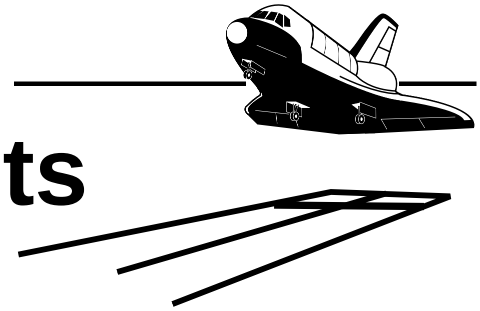
A Publication of the
National Aeronautics and
Space Administration

MH-027/5-94

Mission Highlights STS-59



Space Shuttle *Endeavour*

April 9 - 20, 1994

Commander:
Sidney M. Gutierrez (Col., USAF)
Pilot:
Kevin P. Chilton (Col., USAF)
Payload Commander:
Linda M. Godwin (Ph.D.)
Mission Specialists:
Jerome Apt (Ph.D.)
Michael R. Clifford (Lt. Col., USA)
Thomas D. Jones (Ph.D.)

The payload bay of *Endeavour* features the large antenna of the Spaceborne Imaging Radar-C/X-Band Synthetic Aperature Radar Instrument.

Major Mission Accomplishments

- Completed the first flight of the Space Radar Laboratory (SRL) payload mapping 12% of the total Earth's surface as part of NASA's Mission to Planet Earth Program.
- Conducted investigations in ecology, hydrology, oceanography, geology, and radar calibration, providing researchers with data to distinguish human-induced environmental changes from other natural forms of change.
- Demonstrated the use of advanced multi-frequency, multi-polarized radar as a tool for all-weather, around-the-clock, monitoring of Earth's environment and surface features.
- Conducted special processing of radar data to extract information on the dynamics of the Southern Ocean.
- Successfully conducted global atmospheric measurements of carbon monoxide concentrations, important to global warming studies.
- Conducted the first joint experiment between NASA and the National Institutes of Health, examining muscle and bone cell biology in space.
- Completed nine direct school contacts with students around the world using the Shuttle Amateur Radio EXperiment (SAREX).
- Conducted the growth of twelve Non-Linear Optical (NLO) organic crystals in the Consortium for materials Development in Space Complex Autonomous Payload (CONCAP) experiment.

Out in the woods, lost hikers may try to find some high ground in order to regain their bearings. The high perspective gives hikers a larger field of view to scan the surrounding terrain for points of interest. This is an effective method, unless the hiker's vision is reduced by clouds, fog, or darkness.

Likewise, scientific researchers, policy makers, and military operations require information about specific regions of Earth that may be difficult to obtain due to blocked views or remote locations. The ability to "see" and gather information about objects hidden from optical observation is the driving motivation behind radar imaging from space. One of the most useful feature of imaging radar is its ability to make measurements over virtually any region at any time, regardless of weather or sunlight conditions. At some frequencies, radar waves can also penetrate through vegetation, some types of snow, and extremely dry sand.

STS-59 Crewmembers: (Front L to R) Jerome Apt, Sidney M. Gutierrez, Thomas D. Jones, (Back L to R) Kevin P. Chilton, Linda M. Godwin, and Michael R. Clifford

The STS-59 mission lifted off from the Kennedy Space Center on the 62nd Space Shuttle flight carrying to space the Space Radar Laboratory-1 (SRL-1) payload as part of NASA's Mission to Planet Earth program. SRL consists of the Spaceborne Imaging Radar-C/X-Band Synthetic Aperature Radar (SIR-C/S-SAR) and a sensor to measure carbon monoxide distribution in the lower atmosphere. SIR-C/ X-SAR (actually five separate radars) also contained the Data Processing Assembly to provide direct readout of ocean surface data. SIR-C/C-SAR was jointly developed by NASA, the German Space Agency (DARA), and the Italian Space Agency (ASI). NASA developed the SIR-C (L- and C-band radars). DARA and AST developed the X-band system and all three participated in the integration of these radars into a single instrument, the SIR-C/X-SAR. Also carried in the cargo bay of *Endeavour* with SIR-C/X-SAR was the Measurement of Air Pollution from Satellites (MAPS) developed by the NASA Langley Research Center. NASA will distribute the data and findings of these experiments to assist the international scientific community in essential research for protecting the environment.

Once the crew was on orbit, they powered up the SRL-1 payloads and conducted a checkout of the experiment systems. Ground controllers began uplinking commands to begin radar observations during the eleven day flight. The crew worked in two shifts around the clock to conduct Earth photography and personal observation of weather and environmental conditions to compare to the SRL data after the flight. To aid in postflight data interpretation, the crew documented site conditions by maintaining a written log and taking nearly 14,000 photographs with several cameras and lenses. The crew also performed 412 attitude maneuvers, the most of any Shuttle mission, to reduce radar ambiguities particularly in the X-band frequency radar. The mission returned approximately 47 terabits (47 trillion bits) of data—the equivalent of 20,000 encyclopedia volumes.

The SRL examined over 400 sites on Earth—19 of which were designated as "supersites." These sites were high priority focal points for data collection. Each supersite represented different environments within the scientific disciplines of ecology, hydrology, oceanography, geology, and radar calibration. As such, these are areas where intensive field work has occurred before, during, and after the mission. The supersite locations for ecology included: Manaus, Brazil; Raco, MI.; Duke Forest, NC.; and Central Europe. The supersite locations for hydrology included: Chickasha, OK.; Otzal, Austria; Bebedouro, Brazil; and Montespertoli, Italy. Sites for oceanography included: Gulf Stream, mid-Atlantic; Northeast Atlantic Ocean; and Southern Ocean. The Galapagos Islands, Sahara Desert, Death Valley, Andes Mountains, and Hawaii were the sites for geology. Oberpfaffenhofen, Germany; Kerang, Australia; and Flevoland, The Netherlands were the calibration sites.

Ecologists will use the radar images of the tropical rain and temperate forests to study land use, the volume, types, and extent of vegetation, and the effects of fires, floods, and clear cutting. Hydrologists will use the data to study wetlands and snow cover to estimate the soil moisture. "Hidden" water plays a major role in determining whether a region is wet or dry and influences the global distribution of energy. Oceanographers will use the data to study how the Earth's climate is moderated by the ocean, particularly heat-transporting currents like the U.S. Gulf Stream. Geologists will use the data to map geological structures and rock formations over large areas. They can also use the data to continue studies of features that record past climate changes. On a previous shuttle flight, SIR-A demonstrated the ability to penetrate

Payload Commander Linda Godwin talks with amateur radio operators using the Shuttle Amateur Radio Experiment (SAREX). SAREX is used by the crew to talk with students around the world.

extremely dry sand and discovered ancient river channels in portions of the Sahara Desert. The calibration team will use their results to both test calibration methods and provide calibrated data to the rest of the team.

From the vantage point of space, the SIR-C/X-SAR experiments could record a 15 to 60 km width strip of Earth. Several of the observations by SIR-C/X-SAR were processed into images in real time at the NASA Jet Propulsion Laboratory and shown during the mission. Even with high-speed computer technology, it will still take five months to produce a complete set of survey images from the large volume of data returned.

The MAPS experiment also conducted operations throughout the mission. MAPS measured concentrations of carbon monoxide (CO) around the world. Carbon monoxide plays a key role in the chemical reactions in the atmosphere. Carbon monoxide combines with the hydroxyl (OH) radical and forms carbon dioxide. OH is a key participant in the breakdown and removal of greenhouse gases such as methane, which in turn is important in the chemistry of stratospheric ozone. If the availability of hydroxyl is reduced, the breakdown and removal of greenhouse gases will also be reduced. MAPS primary goal was to measure CO distribution between the altitudes of 4 and 15 kilometers. Two previous shuttle flights of MAPS confirmed that forest and grassland burning in the tropics were a major source of carbon monoxide, greater than previously thought. Preliminary results from STS-59 showed unexpected high concentrations in the Northern Hemisphere and correlation with new observations of fire.

The crew not only examined Earth, but inside the crew compartment, they operated two experiments studying the growth of bone and muscle tissues in microgravity. The Space Tissue Loss/National Institutes of Health (STL/NIH) experiments were the first joint venture between NASA and the NIH. The two separate experiments in middeck lockers both provided nutrients to the cells for growth, while one of the experiments allowed the crew to use a video camera to view the cell growth and downlink the video to investigators from the Walter Reed Army Institute of Research. The research will help scientists understand, on a cellular level, the mechanisms involved in bone loss and muscle atrophy of astronauts during spaceflight and contribute to our understanding of similar problems on Earth.

The crew also continued research on how the human body adapts to microgravity by conducting the Visual Function Tester-4 (VFT-4) experiment. Much like an electronic eye chart, the VFT measures an astronaut's eyes for near and far points of clear vision as well as the ability to change focus within the range of clear vision.

The crew conducted nine educational contacts with students around the world using the Shuttle Amateur Radio EXperiment (SAREX). The SAREX program provides students with the opportunity to talk directly with astronauts in space via amateur radio. The technical aspect of SAREX provides the incentive for students to study math, science, and technology.

In the payload bay, the Consortium for Materials Development in Space Complex Autonomous Payload-IV (CONCAP-IV) developed by the University of Alabama-Huntsville conducted research into the growth of Non-Linear Optical thin films and crystals through physical vapor transportation. Optical crystals are of primary importance in the Optoelectronics and Photonics industry, especially for optical computing. Also in the payload bay were three Get-Away Special (GAS) experiments by students and private researchers examining everything from thermal conductivity measurements of liquids to cellular slime mold growth in microgravity.

Taken by the SIR-C/X-SAR radar on the 40th orbit, this image shows part of Isla Isabela in the western Galapagos Islands. The image shows the rougher lava flows as bright features, while ash deposits and smooth pahoehoe lava flows appear dark.

Mission Facts

Orbiter: *Endeavour*
Mission Dates: April 9 - 20, 1994
Commander: Sidney M. Gutierrez (Col., USAF)
Pilot: Kevin P. Chilton (Col., USAF)
Payload Commander: Linda M. Godwin (Ph.D.)
Mission Specialist: Jerome Apt (Ph.D)
Mission Specialist: Michael R. Clifford (Lt.Col., USA)
Mission Specialist: Thomas D. Jones (Ph.D.)
Mission Duration: 11 days, 5 hours, 49 minutes
Kilometers Traveled: 7,574,784
Orbit Inclination: 57 degrees
Orbits of Earth: 183
Orbital Altitude: 222 km
Payload Mass Up: 9,717 kg
Orbiter Landing Mass: 100,776 kg
Landed: Shuttle Landing Facility (KSC)
Payloads and Experiments:
Space Radar Lab (SRL)- 1
STL/NIH - Space Tissue Loss/National Institute of Health-Cells
VFT-4 - Visual Function Tester
SAREX - Shuttle Amateur Radio EXperiment
CONCAP-IV - Consortium for Materials Development in Space Complex Autonomous Payload
GAS-Get-Away Special

STS-59 Crew Patch

Crew Biographies

Commander: Sidney M. Gutierrez (Col., USAF) Sid Gutierrez was born in Albuquerque, New Mexico. He received a bachelor of science degree in aeronautical engineering from the U.S. Air Force Academy in 1973 and a master's degree in management from Webster College in 1977. He served as a T-38 instructor pilot and flew the F-15 Eagle with the 49th Tactical Fighter Wing. After graduating from the U.S. Air Force Test Pilot School, Gutierrez served as primary test pilot for airframe and propulsion testing on the F-16 Falcon. He has over 500 parachute jumps and more than 4,000 flying hours in approximately 30 different types of vehicles. Gutierrez was named an astronaut in 1984 and flew as pilot on STS-40 in 1991.

Pilot: Kevin P. Chilton (Col., USAF) Kevin Chilton was born in Los Angeles, California. He earned a bachelor of science degree in engineering sciences from the U.S. Air Force Academy and a master of science degree in mechanical engineering from Columbia University. He served as a combat-ready pilot and instructor in the RF-4 Phantom II and the F-15 Eagle. Following graduation from the USAF Test Pilot school, he conducted weapons and systems tests in all models of the F-15 and F-4. He has logged over 4,000 hours of flight time in more than 20 different types of aircraft. Chilton became an astronaut in 1988 and flew as the pilot of Mission STS-49.

Mission Specialist: Linda M. Godwin (Ph.D.) Linda Godwin was born in Cape Girardeau, Missouri, but considers Jackson, Missouri, to be her hometown. She earned a bachelor of science degree from Southeast Missouri State University in physics and mathematics and an MA and Ph.D. in physics from the University of Missouri, Columbia. While at the University of Missouri, she conducted research in low-temperature condensed matter physics where she authored and coauthored several scientific papers. She is an instrument-rated private pilot. She joined NASA in 1980 and served as a flight controller and payloads officer in Mission Control for several Shuttle flights. Godwin was selected as an astronaut in 1985 and is currently Deputy Chief of the Astronaut Office. She previously flew as a mission specialist on STS-37.

Mission Specialist: Thomas D. Jones (Ph.D.) Thomas David Jones was born in 1955 in Baltimore, Maryland. He earned a bachelor of science degree in basic sciences from the U.S. Air Force Academy and a Ph.D. in planetary sciences from the University of Arizona. He served as a B-52 strategic bomber pilot and aircraft commander, accumulating over 2,000 hours of flight experience. After leaving the Air Force, Jones worked toward his doctorate, using remote sensing to investigate the composition of asteroids and meteorites, and researching the utility of asteroid resources in space exploration. He was a program management engineer for the CIA's Office of Development and Engineering and later a senior scientist at Science Applications International Corporation, analyzing future missions to Mars, asteroids, and the outer solar system. He was selected as an astronaut by NASA in 1990. This was his first shuttle flight.

Mission Specialist: Jay Apt (Ph.D.) Jay Apt was born in Springfield, Massachusetts, but considers Pittsburgh, Pennsylvania, to be his hometown. He received a bachelor of arts degree, magna cum laude, in physics from Harvard College, and a doctorate in physics from the Massachusetts Institute of Technology. As a staff member of Harvard's Center for Earth and Planetary Physics, he supported NASA's Pioneer Venus Mission. While at NASA's Jet Propulsion Laboratory, Apt studied Venus, Mars, and the outer solar system and was Science Manager of the Table Mountain Observatory. From 1982 until his selection as an astronaut in 1985, he was a flight controller responsible for Shuttle payload operations at NASA's Johnson Space Center. He has logged over 3,000 hours flying time in some 30 different types of vehicles. Apt served as a mission specialist on the STS-37 and 47 missions.

Mission Specialist: Michael Richard Clifford (LTC, USA) Rich Clifford was born in San Bernadino, California, but considers Ogden, Utah, to be his hometown. He earned a bachelor of science degree from the United States Military Academy and a master of science degree in aerospace engineering from the Georgia Institute of Technology. Clifford served with the 10th Cavalry and then completed pilot training as the top graduate of his class. He served in a variety of positions with the 2nd Armored Cavalry Regiment in Germany and was an assistant professor of mechanical engineering at West Point. Clifford became an experimental test pilot following graduation from the U.S. Naval Test Pilot School in 1986. He has flown over 3,000 hours in more than 50 types of aircraft. Clifford became an astronaut in 1990. He flew as a mission specialist on STS-53 aboard *Discovery* in December 1992.